(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 048 310**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 80303313.3

(22) Date of filing: 22.09.80

(51) Int. Cl.³: B 01 D 46/52
//B01D29/26, B01D46/24

(43) Date of publication of application:
31.03.82 Bulletin 82/13

(84) Designated Contracting States:
BE DE FR GB IT NL SE

(71) Applicant: INCOM INTERNATIONAL INC.
415 Holiday Drive
Pittsburgh, Pennsylvania 15220(US)

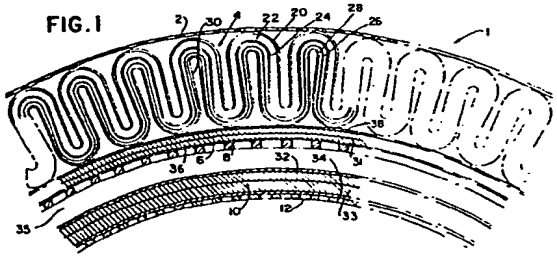
(72) Inventor: Ting, C. Tao
25000 Miles Road
Cleveland Ohio 44128(US)

(74) Representative: Matthews, Howard Nicholas
MATTHEWS HADDAN & CO HADDAN HOUSE 33
Elmfield Road
Bromley Kent BR1 1SU(GB)

(54) **Air-oil separator.**

(57) A two-stage air-oil separator (1) is connected to the air exhaust system of a compressor. The first stage has a pleated extended area agglomerator (4) formed of layers of glass fiber material. The second stage has radially spaced filter elements (6, 10) with high loft filter material (31, 33) layers held between vinyl-coated glass scrims (32, 34, 36, 38). The layers in the various filter elements are wrapped with different tightness. Fluid inlets and outlets are provided.

FIG. I



EP 0 048 310 A1

This invention relates generally to liquid separators having plural distinct elements mounted concentrically. More particularly, this invention has reference to an air-oil separator having pleated agglomerator media.

Many problems remain in the prior art devices. One problem lies in the excessive pressure drop that occurs as the fluid passes through the filtering media. Another problem lies in the excessively large size required for prior art filters having an air flow capacity sufficient for use with compressors. Another problem lies in the tendence of prior art filtering media to compress under the air pressures encountered in a compressor exhaust system and thereby decrease the operating efficiency of the compressor system.

The present invention overcomes many of the problems which exist in the prior art devices. The present invention provides a two-stage air-oil separator connected to the exhaust system of an air compressor.

The first stage has a pleated extended area agglomerator formed of layered material. The pleated filter permits significant reduction in the size of the overall separator for a given air flow capacity. The pleated agglomerator medium used in the first stage has layers of fiberglass positioned between screens. This agglomerator medium, when pleated, causes little pressure drop in the air passing through the separator. In addition, this particular first stage avoids the problem of

excessive compressing of agglomerator media common in prior art devices.

The second stage has radially spaced filter elements with high loft filter material layers held between vinyl coated glass scrims. Such a double second stage filter element permits further reduction in size. By wrapping the layers in the various filter elements with different degrees of tightness, improved filtration efficiency and effectiveness occur with a minimum pressure drop.

Figure 1 is a fragmentary cross sectional view of the separator of the present invention.

Figure 2 is a fragmentary cross sectional view of a typical prior art separator.

Figure 3 is an elevational view, in section, of a portion of one embodiment of the separator of the present invention.

Figure 4 is an elevational view, in section, of a portion of another embodiment of the separator of the present invention.

Figure 5 is a perspective view, partly in section, of a separator installed vertically in an oil tank.

Figure 6 is an elevational view, partially in section, showing a separator embodiment in which oil mist laden air flows from within the separator and clean air flows radially outward from the separator.

Figure 7 is a detail of the separator embodiment shown in Figure 6.

Figure 8 shows horizontal installation of a separator with a single second stage.

Figure 9 shows a detail of a similarly installed separator with a double second stage.

Figure 10 shows a horizontal embodiment of a separator with second stage filter discs.

Referring now to FIGURE 1, the separator of the present invention is shown generally by the numeral 1. As will become apparent, the general purpose of the separator 1 is to remove oil mist from the pressurized air exhausted from a compressor outlet.

The separator 1 has two stages. The agglomerator stage 4 is positioned adjacent the outer wall 2 of the separator 1. The second stage is a double filtering stage having two filter elements 6 and 10 positioned adjacent inner walls 8 and 12 of the separator 1. Preferably, the separator walls 2, 8 and 12 are perforated steel cylinders.

The agglomerator 4 has a pleated multilayer agglomerator media. The outer layer 20 of the agglomerator media is a single layer of mesh metal screen. Similarly, the inner layer 30 is a single layer of mesh metal screen. The central layer 24 of the agglomerator media is a single layer of fiber glass sheet. Positioned between the fiber glass sheet 24 and the adjacent mesh metal screens 20 and 30 are intermediate layers 22, 26 and 28 formed of a fiber glass media. A single layer of fiber glass media 22 is positioned between the fiber glass sheet 24 and the outer screen 20. Two layers of fiber glass media 26 and 28 are positioned between the fiber glass sheet 24 and the inner screen 30. Preferably, the fiber glass sheet 24 has a low loft and the fiber glass media 22, 26 and 28 has a substantially higher loft. The latter may be used without the low loft sheet.

Various other agglomerator materials may be substituted without departing from the scope of the present invention. Similarly, various other layering arrangements which will be obvious to persons skilled in the art do not depart from the scope of the present invention. However, the specific agglomerator

materials and layering arrangement described is preferred. This agglomerator structure proved high resistant to compressive forces exerted by the pressurized air passing through the filter. In addition, the preferred agglomerator 4 caused little pressure drop in the air passing through the filter and performed the agglomerating function, later described in greater detail, effectively.

The filter elements 6 and 10 in the second stage have two layers of filter media 31 and 33 positioned between vinyl coated glass scrims 32, 34, 36 and 38. The outer filter element 6 is held against the inner circumference of the agglomerator 4 by a perforated steel cylinder 8 concentrically spaced within the outer wall 2 of the separator 1. The inner filter element 10 is secured adjacent the inner wall 12 of the separator 1. A cylindrical space 35 is provided between the inner and outer filter elements 6 and 10.

The filter elements 6 and 10 separate oil from air in a manner more fully described later. The second stage facilitates the draining of the oil. The dual element filtering configuration used in the present invention further permits a reduction in the overall size of the separator 1 for a given air flow capacity.

Large radial forces are supported by heavy cylinder 8. Layers 31 in the outer filter element 6 are wrapped tightly around the perforated steel cylinder 8 and the layers 33 in the inner filtering element 10 are wrapped around the inner steel cylinder 12. This construction provides effective filtering capability with a minimum pressure drop in the air passing through the separator 1.

The separator 40 shown in Figure 2 is similar to those generally used in the prior art to separate oil mist from compressor exhaust air. Generally, the prior art separator has three radially spaced concentric perforated steel cylinders 42, 46 and 50. The outer filtering stage has a plurality of layers of fiber glass media 44 positioned between concentrically spaced glass scrims 41 and 43. The outer filter element is held between the outer and central steel cylinders 42 and 46. The inner filter element has a plurality of layers of fiber glass media 48 held between a vinyl coated glass scrim 45 and the inner perforated steel cylinder 50. The prior art separator 40 has less oil loading surface area than the pleated separator 1 of the present invention. Consequently, the present separator 1 can be made much smaller than the prior art separator 40 and still handle the same air flow capacity. In addition, the plurality of fiber glass media wrappings 44 and 48 in the prior art separator 40 tend to compress and compact more easily than the agglomerating and filter media in the present separator 1 when subjected to high pressure air streams. When the fiber glass media layers 44 and 48 in the prior art separator 40 are compressed, a significant pressure drop occurs. The present separator 1 avoids this problem.

Figures 3-10 show various embodiments of the present invention and various mounting supports used with the present invention.

Figure 3 has a single second stage 10 supported between a perforated inner wall 12 and scrim 32. Figure 4 employs a dual second stage, Filter 6 is added between pleated accumulation 4 and perforated cylinder 8. Mounting end 64 is supplied with gaskets 84. Tube 90 withdraws oil from within the filter. Straps 93 hold the casings assembled.

Figure 5 shows a vertically mounted separator. An inlet port 94 formed in the side wall of a compressor oil sump 86 is connected to the pressurized air outlet (now shown) of an air compressor. Pressurized air enters the port 94 and impinges upon the separator.

Oil 97 within the tank is returned to the compressor through pipe 96 which extends to a point near the bottom of the tank.

Oil mist laden air enters the separator through pleasted element 4 of the first stage. Heavy screen 8 supports the pleated element 4 against the pressure differential, while the oil is being agglomerated into large drops by the separator element 4. The air continues through second stage element 6 which is supported by a perforated cylinder 7, and oil free dry air goes out of the large pipe at the top of the separator. Some oil collects on the outer screen 2 and flows downward, collecting at the bottom of the main tank. Other oil flows through the stages of the separator and is collected at the base 56 of the separator. Oil tube 90 leads the oil from the relatively high pressure interior of the separator to the atmospheric pressure intake of the compressor.

The separator shown in Figure 6 and its detail shown in Figure 7 flow oil mist laden air from the inside of separator 100 through the outside. The oil laden air flows in through an opening in one of the ends 110 or 112, and the air flows radially outward through the filter elements. Oil free dry air is collected in a circumferential shroud and is piped to a cooler or to another device or use.

The oil mist laden air infringes upon screen 2 and flows through pleated layered agglomerator 4. Some of the oil drips from the screen 2 and the inside of element 4 downward through the open lower end 112 into the oil sump tank. The air continues outward through the heavy perforated radial thrust cylinder 8 and through the grid 9 around which filter element 6 is wrapped.

The air continues outward through the second stage filter element 6 and through the relatively light perforated metal cylinder, grid or screen 7, where the oil free air is collected and used. A tube in the outer shroud similar to tube 90 collects oil which has flowed through the separator elements and returns oil to the compressor.

A horizontal mounting of the separator unit is shown in Figure 8. A tank 140 has a heavy cylinder 142 with a welded end plate 144. A separator unit is inserted through a large upper opening in end plate 144 and a cover plate 146 is bolted to the end plate with the gasketed filter flanges in between.

A central opening 148 in cover plate 146 flows oil free dry compressed air outward through connected piping, which is not shown. An oil opening 150 near the bottom of the plate is connected to piping which flows oil to the intake of a compressor. Oil is collected in a low spot near the cover plate and near opening 150 as it drops from short tube 152 which is inserted through end cap 158 between the first and second stages 4 and 6.

The filter elements and perforated plates and gaskets are held between end caps 156 and 158. Flanged cup 160 is welded to end cap 158 and extends outward between gaskets which separate the cup flange from the tank end plate 144 and the cover plate 146. Bolts 162 inserted through the cover plate 146 and the flange secure the cover plate and separator to the end plate 144 of the tank. Oil laden air flows through the outer perforated cylinder 2 and pleated multilayer agglomerator element 4. Some oil flows from perforated plate 2 and element 4 in the forms of large drops which drip into tank 140. Air and large drops of oil flow inward through heavy inward thrust sustaining perforated cylinder 8 and the air continues to flow through perforated cylinder 9, second stage element 6, and inner support plate 7. Oil is removed from between the first and second stages by short tube 152 and flows into a lower area near oil opening 150.

As shown in Figure 9, a double second stage element is mounted horizontally within the tank similar to the tank shown in Figure 8. Oil which collects between first and second stages flows outward through a short pipe 152 and through oil opening 150 in cover plate 146. The double second stage separator shown in Figure 9 is similar to the separator shown in Figure 8 with the addition of second stage filter material 6 which is wrapped around an inner perforated cylinder 8. Oil migrates to the area where it is removed by short tube 152.

Figure 10 shows a horizontal embodiment of the invention. Pleated agglomerator 4 is mounted on a horizontal axis. Dual secondary elements are in the form of discs 74 and 78, having compositions similar to filter elements 6 and 10 as shown in Figure 1.

A cup-shaped mount 64 has welded straps 78 and 82 secured thereto to support a secondary filter disc assembly composed of inner and outer screens 72 and 80 and filter discs 74 and 78, which are separated by a foraminous metal disc 75. Flanges of the filter assembly are covered by gaskets 84 for mounting between a tank and cover. Primary filter 4 is supported between perforated plates 2 and 8 and straps 71 connect the inward base plate 56 to the remainder of the filter assembly.

The horizontal version as shown in Figure 10 uses secondary stage filter discs 74 and 78 instead of the second stage cylinder.

While the invention has been described with reference to specific embodiments, modifications and variations of the invention may be made without departing from the scope of the invention. The scope of the invention is described in the following claims.

CLAIMS:

1. Separator apparatus comprising

upper and lower supports

radially spaced annular permeable casings concentrically disposed about a central axial core,

annular pleated agglomerator media extending between said casings comprising relatively falt sheet agglomerator material interposed between layers of agglomerator material having relatively high loft,

said casings and said agglomerator media having upper and lower ends disposed in sealing relationship with the upper and lower supports respectively.

2. The apparatus of Claim 1 wherein

said sheet agglomerator material and said high loft agglomerator material comprise material fromed of glass fibers.

3. The apparatus of Claim 1 wherein

the annular pleated agglomerator media further comprises mesh screens received on the outer surfaces of the layers of high loft agglomerator material to maintain the outer peripheries of the agglomerator media in fixed relationship.

4. The apparatus of Claim 3 wherein

the mesh screens comprise mesh aluminum screens.

EPC Patent Application No. 80303313.3
INCOM INTERNATIONAL INC.

Page 12

Claim 7 - Delete "13", replace by "6"

Claim 8 - Delete "13", replace by "6"

THE CORRECTIONS ARE ALLOWED UNDER RULE 88

07 JUIL. 1981 M. VAN MOL

MATTHEWS, HADDAN & CO.,
Haddan House,
33 Elmfield Road,
BROMLEY, Kent. BR1 1SU.

5. The apparatus of Claim 1 wherein

the flat sheet agglomerator material is interposed between a single layer of high loft agglomerator material and two superposed layers of high loft agglomerator material, said single layer received on the radially outward surface of the flat sheet agglomerator material.

6. Separator appratus comprising

upper and lower supports,

first and second filter means disposed concentrically about a central axial core and extending axially between the supports for agglomerating and filtering fluids,

said first filter means comprising pleated agglomerator media having upper and lower ends disposed in sealing relationship with the upper and lower supports respectively,

said second filter means comprising radially spaced annular filter elements concentrically disposed about the core comprising layers of filter material having relatively high loft having upper and lower ends disposed in sealing relationship with the upper and lower supports respectively.

7. The apparatus of Claim 13 wherein

the high loft filter material comprises material formed of synthetic material.

8. The apparatus of Claim 13 wherein

the sheets of permeable casing comprise vinyl coated glass scrims.

9. The apparatus of Claim 6 further comprising

filter intake means provided in the radially outward surface of the first filter means for supplying fluid to the first filter means,

filter outlet means provided in one of the support means and communicating with the core for exhausting fluid from the core, and wherein

the second filter means is positioned radially inwardly of the first filter means and is in fluid communication with the first filter means for communicating fluid from the filter intake means to filter outlet means.

10. The apparatus of Claim 6 wherein

the layers of filter material in the radially outermost filter element are wrapped relatively tightly about the radially inward sheet of casing,

and the layers of filter material in the radially innermost filter element are wrapped relatively less tightly than the layers of filter material in the radially outermost filter element.

11. Air-oil separator apparatus adapted for use in air exhaust systems of high pressure air compressors comprising

upper and lower supports,

filter means disposed concentrically about a central axial core and extending axially between the supports for separating agglomerated oil from air,

agglomerator means disposed concentrically about the filter means and extending axially between the supports for agglomerating oil mist in air comprising pleated agglomerator media

intake means provided in the agglomerator means for communicating oil mist laden air from a compressor outlet to the agglomerator means,

outlet means provided in one of the supports and communicating with the core for exhausting air from the core and wherein

the filter means and agglomerator means are in fluid communication for communicating fluid from the intake means to the outlet means and thereby supplying air free of oil to the outlet means.

12. The apparatus of Claim 11 wherein

the filter means comprises radially spaced annular filter elements concentrically disposed about the core.

FIG. 1

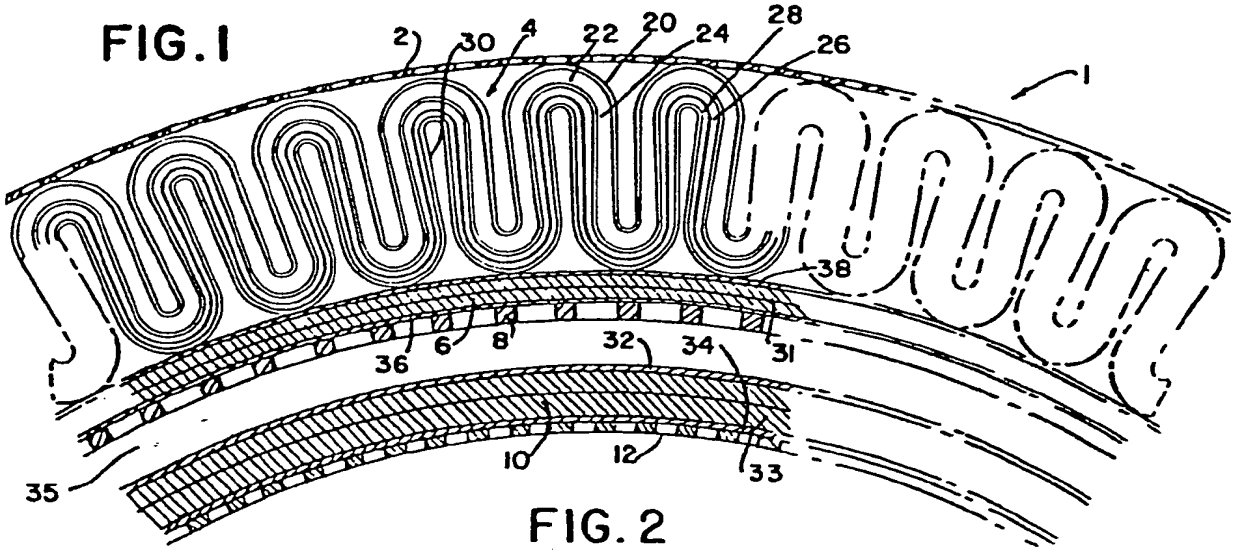
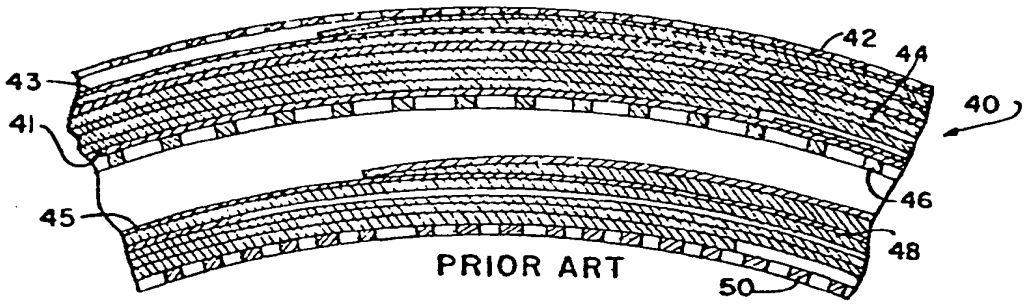


FIG. 2



PRIOR ART

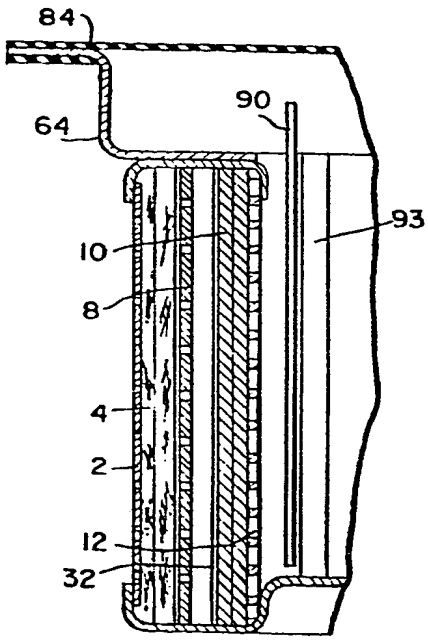


FIG. 3

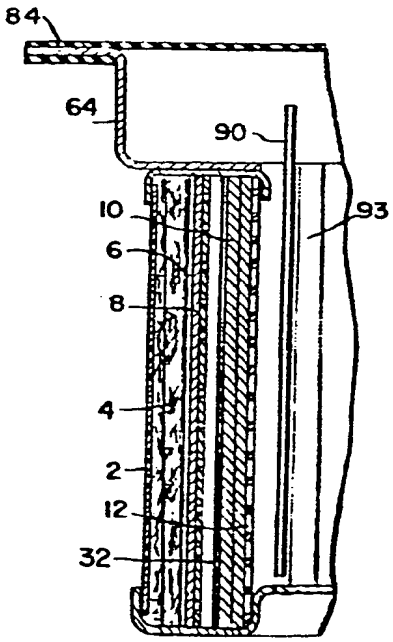


FIG. 4

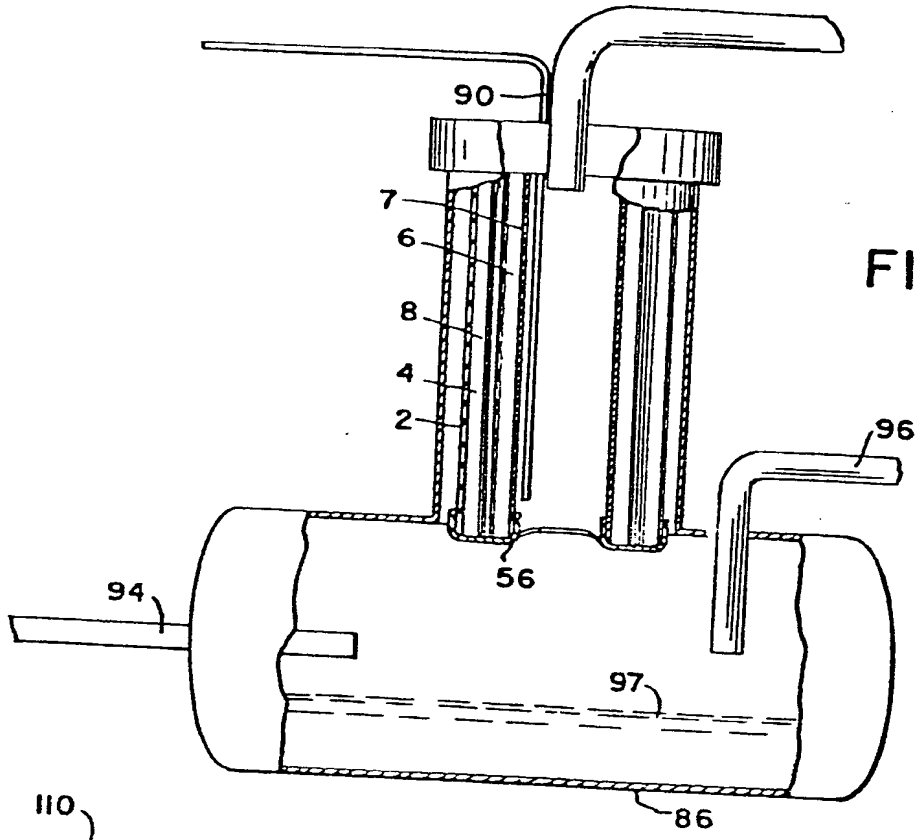


FIG. 5

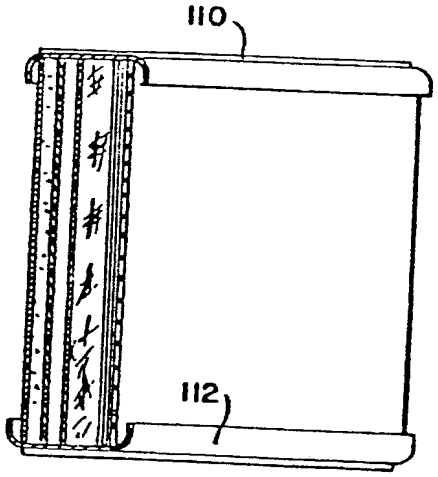


FIG. 6

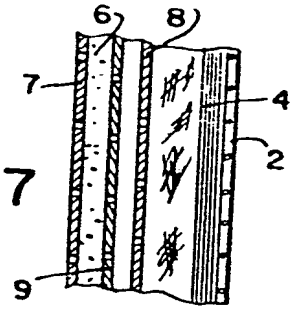


FIG. 7

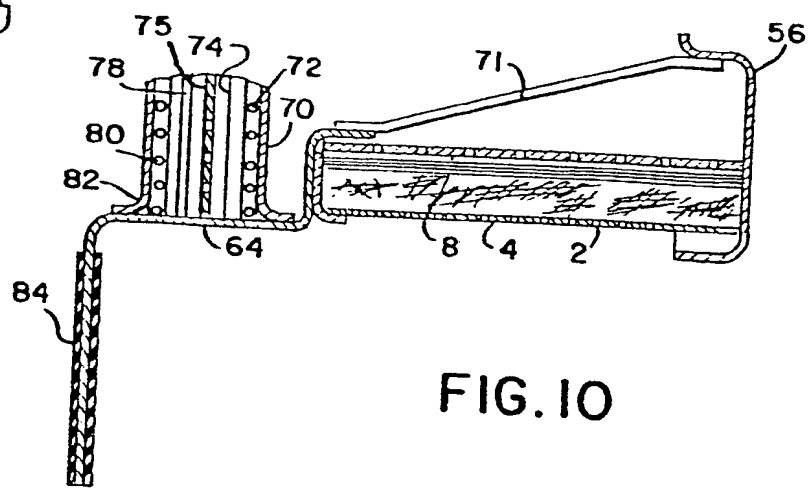


FIG. 10

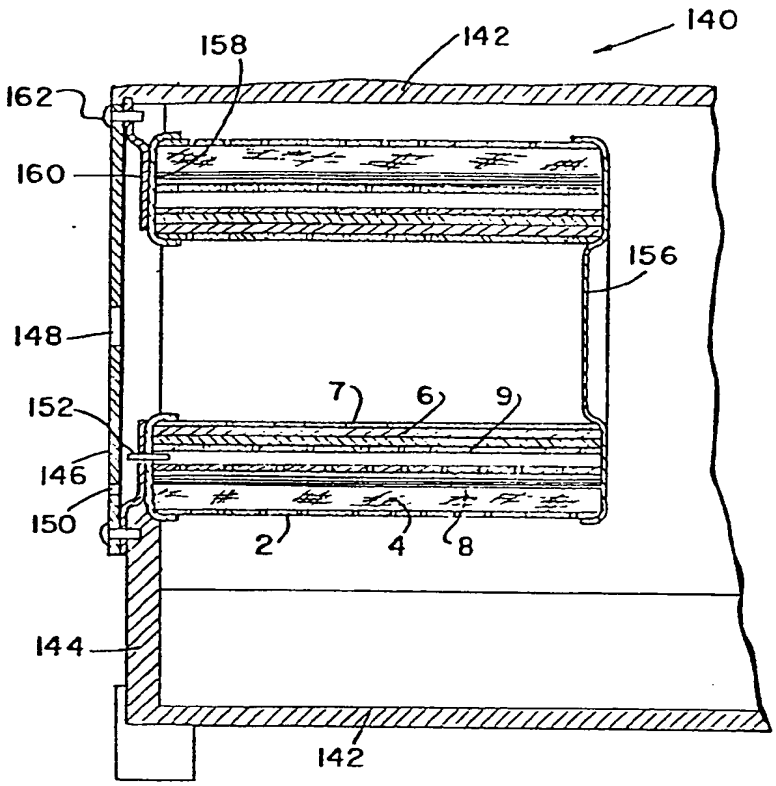


FIG. 8

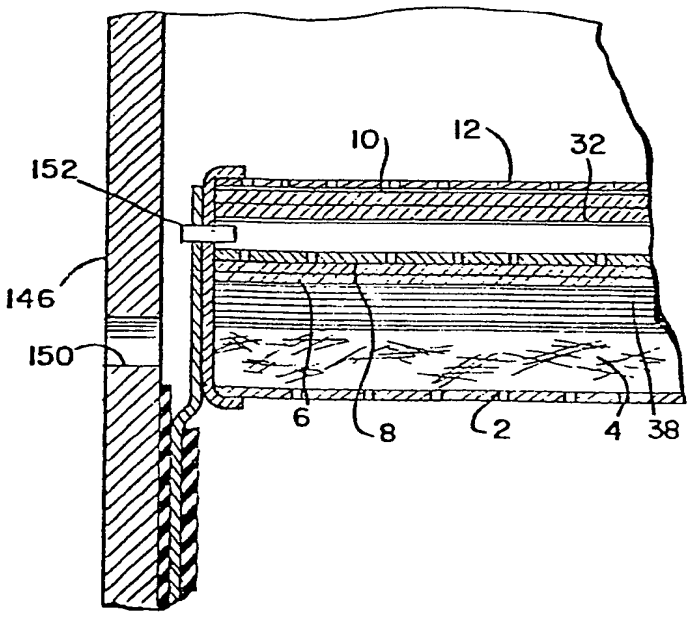


FIG. 9

European Patent Office

EUROPEAN SEARCH REPORT

0048310

Application number

EP 80 30 3313.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	US - A - 2 864 505 (W. KASTEN) * fig. 1 to 3 *	1,2, 6,9
	US -A - 3 920 428 (H.B. KINSLEY) * claim 1 *	8
	US - A - 4 050 237 (D.B. PALL et al.) * claim 1; fig. 1, 2 *	11
	US - A - 4 089 783 (K. HOLYOAK) * fig. 1, 2 *	2-4
	CH - A5 - 619 152 (PROCESS SCIENTIFIC INNOVATIONS) * claims 1, 4; fig. 2 *	2,3, 7,8
	DE - C - 721 537 (I.G. FARBENINDUSTRIE) * claim, page 2, lines 12, 19 *	8
	DE - C - 852 839 (BADISCHE ANILIN- & SODA-FABRIK) * example 1 *	8
A	US - A - 1 566 088 (O.V. GREENE) * fig. 8 *	
A	US - A - 1 883 715 (O.V. GREENE) * fig. 4, 6 *	

./..

CLASSIFICATION OF THE APPLICATION (Int. Cl ³)

B 01 D 46/52
//B 01 D 29/26
B 01 D 46/24

TECHNICAL FIELDS SEARCHED (Int. Cl ³)

B 01 D 27/06
B 01 D 29/16
B 01 D 29/26
B 01 D 39/02
B 01 D 39/08
B 01 D 39/14
B 01 D 39/16
B 01 D 46/10
B 01 D 46/24
B 01 D 46/52

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E. conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	12-06-1981	KÜHN

EPO Form 1503.1 06.78

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 80 30 3313.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	US - A - 2 865 510 (R.W. GREENE) * fig. 3 to 5a * --	
A	US - A - 3 552 553 (J.E. READING) * fig. 4 * --	
A	US - A - 3 592 767 (D.B. PALL) * fig. 4 * --	
A	FR - A - 1 349 089 (A. KNECHT) * fig. 1, 2 * ----	

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

TECHNICAL FIELDS SEARCHED (Int. Cl.³)